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ADVANTAGES AND DISADVANTAGES OF DOLLAR UNIT SAMPLING

BY

Barry Lalonde and Julia Lelik

MARCH 1984

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Advantages and Disadvantages of Dollar Unit Sampling

Background

The Office relies on sampling of all kinds (both statistical and judgemental) as a basis for its audit conclusions. The validity of sampling decisions directly affects the cost, effectiveness and credibility of an audit.

The Office is developing a framework of policies, guidelines and methodology on sampling. However, for the most part, audit staff now use their professional judgement based on individual experience and varied training backgrounds. The importance of developing a sampling framework is underscored by the many statistical sampling techniques that have come into wide use within the Office as a supplement to judgemental sampling. For example, growing numbers of audit staff have begun to use dollar-unit sampling. Accordingly, the Office considered that research into the advantages and disadvantages of this approach would help us to understand it more, and that such research would be a step toward developing a broader knowledge base for sampling.

This paper was undertaken as a joint project by the Methodology and Computer Audit Services groups and was prepared by Julia Lelik under contract to the Office from Peat, Marwick, Mitchell & Co., under the direction of Barry J. Lalonde.

This paper assumes that readers are familiar with the basic concepts of Dollar Unit Sampling (DUS). Those who are not are encouraged to consult any number of texts that cover the subject in more depth than is possible here.

Dollar Unit Sampling has become what Kaplan has referred to as "an important contribution and must be considered as one of the prime statistical sampling procedures available to auditors".[1] However, although it is often used as a sampling method, it is only one among many. Therefore, it is felt that a

discussion of the pros and cons of one method, such as DUS, naturally involves a comparison with others. Therefore, we have included the following overview of the "competing" methods.

Statistical Sampling Methods - An Overview

It has been concluded that "the ultimate objective of statistics is to make inferences about a population based on information contained in a sample".[2] Loebbecke and Neter have summarized the application of that premise as follows:

> "The choice of statistical sampling procedures in auditing encompasses selecting (1) a method of sampling, (2) one or more statistics to be calculated from the sample, and (3) a methodology for assessing the sample results."[3]

In auditing, two categories of statistics that are calculated for a sample (and which in turn are extrapolated to the population) have evolved. Appendix A depicts these as based on proportion or value. Although judgemental sampling or non-statistical sampling is shown, no reference will be made to it here. An interesting rebuttal to the use of statistical sampling is found in a recent paper by Graham Cosserat.[4]

Proportion estimation is intended to establish the rate at which some characteristic of interest occurs in the population. It involves defining an attribute that either applies or does not apply to the sample item. For example, a control is found to have been applied to a specific invoice or it has not. **Discovery sampling** is a form of attribute sampling when the auditor designs the sampling plan with an expected error rate of zero. This is usually done if preliminary evaluations support the belief that the actual rate of error in a given population will be low. **Acceptance sampling**, on the other hand, is a form of attribute sampling when the auditor expects other than a zero error rate. Consequently, the auditor would plan a sample such that some rate of error can be tolerated. Later, it will be shown that although these concepts are generally applied to compliance testing, they form in part the underlying concepts of dollar unit sampling (DUS).

Value oriented sampling involves using an estimator to reach a conclusion about a population that is expressed in dollars. Two categories of sampling have been developed in this context; Probability-Proportional-to-Size sampling and variables estimation. DUS is included in the former. The variables methods include ratio estimation, difference estimation and mean-per-unit.

Mean-per-unit sampling involves drawing a sample (for example, of n) from a population containing N items, so that every possible sample has the same chance of being selected. The estimator used, is the mean or average value. Accordingly, the value of the population is represented as:

Total estimated value = number of items in the population x mean value.

In addition, a range of values or precision can be calculated using the concept of a standard deviation which is an estimate of a population's variance. This measures the spread or variation around the estimator. Tchebysheff's Theorem states "at least $(1 - 1/k^2)$ of a set of measurements will lie within K standard deviations of their mean. For example, letting K = 2 one would expect at least 3/4 of a set of measurements to lie within 2 standard deviations of their mean".[4] This represents the lower bound of the estimation process. In addition, the Empirical Rule, which applies exactly to normally distributed data, states that approximately 95% of the measurements will be within 2 standard deviations of the mean.

"The measurements of primary interest to a statistician are the set of estimates generated by an estimator in repeated sampling. Tchebysheff's Theorem and the Empirical Rule imply that most (at least 75%, and likely 95%) of the estimates generated in repeated sampling will be within 2 standard deviations of the mean of the estimator."[5]

Ratio estimation involves using an additional subsidiary variable. The approach in auditing involves using the ratio of the audited value of an item subject to sampling to its book value. It involves obtaining the mean value for each and extending to the population as follows:

$$\text{Total estimated value} = \frac{\text{Average Audit Value}}{\text{Average Book Value}} \times \text{Book Value}$$

Again, variation is measured using formula incorporating the spread of value around each mean.

Difference estimation sampling involves taking the mean value of the difference between the audited value and the book value extended to the population as a total estimated value.

Total estimated value = Number of items in the population x (Average audited value - average book value)

As in the case of the mean-per-unit and ratio methods, a specific reliability level is calculated for a range of variation around the population's point estimate. Additionally, although the foregoing discussions address the methods only from a simple random selection viewpoint, each method often uses stratification. Stratification involves segmenting the population into non-overlapping groups, generally on the basis of dollar values and selecting a simple random sample from each group or strata. It yields stratified mean-per-unit as well as stratified ratio and difference methods.

The overview in Appendix A views variable sampling from an estimation perspective, i.e., the population value is calculated as a point estimate, together with a confidence range (i.e., the variation). The literature also refers to hypothesis testing -- testing to establish whether the estimated population value lies within a non-material range. If it does not fall within the range, the value is rejected. The authors are inclined to agree with Anderson and Leslie's statement that:

> "Estimation and hypothesis testing are so closely related that we question whether the distinction between them will ever be of practical value to the auditor."[6]

The variables' methods discussed so far, depend on a normal distribution of data. Generally, the information needed to calculate sample sizes involves

prior knowledge of variance, size of the population and reliability or confidence levels.

Dollar Unit Sampling

Description of DUS Methodology

Dollar Unit Sampling is a value oriented adaption of the attribute sampling approach that allows the auditor to express a rate of error in a given population in terms of dollars. The principle involves treating the population as if it were composed of individual dollars. These are considered to be the sampling units rather than physical units such as balances or invoices. Dollar Unit Sampling involves taking a random sample of dollars from the population of dollars and determining whether or not the selected dollar is correctly recorded. Pragmatically, however, an auditor cannot audit a specific dollar within a population. Because the sampling unit is a dollar within a population of dollars, the approach involves auditing the physical unit within which the dollar falls and ascribing the characteristic of the dollars in the physical unit to the dollar selected. The proportion of incorrect dollars in any physical unit is referred to as the "tainting percentage".

The probability of selecting a given physical unit depends directly on the number of dollars in that unit. For example, an invoice having 100 dollars which forms part of a population of 1,000 dollars has 10 times the chance of being selected than one which contains only 10 dollars. This notion is fundamental to the Probability-Proportional-to-Size sampling methods illustrated in Appendix A.

In calculating sample sizes, the formula generally applied involves use of the Poisson approximation of a limiting case of the Binomial distribution. The limiting case uses the assumption that errors in the population (p) tend to be small (tends to zero) and the product of sample size and p is constant. Consequently, the formula for the Poisson distribution assuming zero errors can be used as follows:

$$n = \frac{-\ln B}{UEL}$$

Where n = sample size

B = the risk that the sample results would lead the auditor to believe that no material error in the population exists when it indeed does (converse of confidence level).

UEL = upper error limit or "the measure of the possible extent of errors in a population".[7]

UEL is the error rate within a population. It can be expressed as possible dollar error as a percentage of book value, namely the population subject to audit. This possible error has been referred to as monetary precision, materiality or gauge. We will henceforth refer to it as planning materiality (PM). Also the -ln(B) is expressed as UEL factor, R- factor or Sample Size factor. We will refer to it as SSF or sample size factor. The formula therefore becomes

$$n = \frac{\text{SSF x Book Value}}{\text{PM}}$$

A sampling interval is then calculated (Book Value is divided by sample size) that will help in determining which dollar in the population will be selected for audit. The population is then broken down into these intervals, and a dollar within each cell or interval is selected at random. The process generally involves adding through the population by applying a systematic sample with a random start. Once the dollar is selected, it acts as a hook, bringing with it the physical item to which an auditor can apply procedures.

After the sample items have been audited, the errors are projected to the population. The same formula as above is applied, but the precision (which was PM for planning purposes) is solved for as the terms are rearranged.

$$\text{Precision} = \text{SSF x } \frac{\text{BV}}{n} = \text{SSF x Sampling Interval}$$

The sample size factor has three components, namely, basic precision, most likely error, and precision-gap widening. **Basic precision** is the amount of possible error in the population, assuming the sample had zero errors. **Most likely error** is the tainting percentage multiplied by the number of errors encountered. **Precision-gap widening** is the incremental increase in the possible error in the population above that of the basic precision for each error found. It is generally calculated by multiplying the tainting percentages by the incremental increase in the sample size factor (for each error) or precision-gap widening factor, also in descending order. Each of these components is then multiplied by the sampling interval. The sum of the three components so calculated becomes the total possible error in the population.

The process described ensures that any individual physical item with a book value greater than the sampling interval will be selected. Most often these amounts are considered to be top strata items and subject to 100% audit verification. Any error found is not projected to the population.

It has been shown that DUS depends on the binominal or, when approximated, a Poisson distribution of data. Information required to compute sample sizes involves knowledge of planning materiality and Beta risk or confidence levels.

Advantages and Disadvantages

The advantages and disadvantages (strengths and weaknesses) of DUS will be reviewed under the following headings:

A. Reliability
B. Relevance
C. Conservatism
D. Objectivity
E. Practicality

Auditors intuitively (and sometimes explicitly) consider these characteristics or variables in assessing and designing audit procedures. The points

under each heading above will not be presented in any order of importance or preference. Any such ranking would depend on the particular audit in which a given sampling technique is to be used. For instance, an external auditor is concerned first and foremost with expressing an opinion on the financial statements to be presented to an enterprise's shareholders; the auditor seeks to audit to a "presents fairly" standard. In contrast, an operational auditor is more concerned with establishing the efficiency, effectiveness or appropriateness of a specific control procedure or expenditure. In an operational audit, the population from which a sample is drawn may bear little relationship to an accounting balance upon which the external auditor may offer his or her opinions.

A. Reliability

Reliability used in this context denotes the extent to which the approach yields appropriate audit results.

Advantages

1. DUS is able to deal with the skewness which has been attributed to most audit populations. Newman states "For many years some accountants have used a rule of thumb for accounting populations which states that 80 percent of the items represent 20 percent of the value and the remaining 20 percent of the items represent 80 percent of the value".[9] This concept is based on an examination of the distribution of the book values of audit populations, and we have found no literature that examines this distribution from the point of view of audit values. Of course, the use of DUS is predicated on the assumption that most audit populations contain a small rate of error and, therefore, most audit values would also equal book values.

2. Variables sampling plans that are dependent on average values per physical unit audited, must face the problem of estimating standard deviations of the error value of each stratum within the population. We therefore need prior knowledge on error distributions within populations. DUS eliminates this problem by using the sampling

interval and applying the tainting percentage as representative of the dollars in that interval. Therefore, DUS does not require prior knowledge of standard deviations.

3. Stringer, Anderson and Teitlebaum have indicated that when no errors in a sample are found using ratio or difference methods, the results appear to imply a perfect population. This assumption, based on empirical evidence discussed in a paper prepared by Loebbecke & Neter,[10] occurs when a population contains a low rate of error. On the other hand, DUS provides a measure of possible error (or basic precision) even if no errors have been found in the sample.

Disadvantages

1. Very little has been found in the literature on the actual distribution of errors within audit populations. DUS increases the chances that high valued items will be selected. Intuitively it could be argued that these large items would be subject to greater scrutiny by enterprises simply because they are large. A company would bear greater exposure to loss if errors occurred in such items. On the other hand, errors may frequently occur in middle or lower valued items, which are less likely to be selected for audit. Nevertheless, in the aggregate, they may result in material errors. Because variable sampling (unless stratification is used) does not depend on the size of physical items, it is less likely to result in the problems noted above.

2. When many errors occur in a population, DUS becomes exceedingly conservative because each error contributes to an increase in possible error. In such situations, some of the variable methods would be more appropriate.

3. Because DUS mixes arbitrary assumptions (such as tainting percentages) in the evaluation phase with objective application of statistical theory arising from attribute sampling, there is a danger that an

auditor may draw an invalid conclusion based on the result of a sample.

4. The literature demonstrates the use of DUS primarily in auditing accounts receivable and inventories, and discusses the concepts in terms of overstatement errors. A problem which persists is the treatment and netting of understatement errors. (See also discussion of item 3 under relevance.)

5. DUS is perceived to be most effective when the amount of overstatement error does not exceed the book value of the physical unit to be audited. When taintings become greater than 100% distortions in the precision measured could occur because the projection is over a sampling interval. This interval assumes that the planning materiality, used to calculate both the interval and sample size, could be at worst only 100% wrong.

6. We can project errors only to the population of dollars from which we sample, and not beyond, because a systematic sample assumes our population is complete. Where many such errors occur with greater than 100% taintings, there would be doubt that we have selected from a complete population.

B. Relevance

Advantage

1. When DUS, being a form of attribute sampling, is applied to testing of an internal control, scientific evidence as to the effectiveness of the control exists. This evidence helps in assessing the degree of reliance to be placed on internal control when deciding on the nature, extent and timing of year end substantive procedures. This better aids in addressing the second examination standard within Generally Accepted Auditing Standards found in paragraph 5100.02(ii) of the CICA Handbook which states:

"There should be an appropriately organized study and evaluation of those internal controls on which the auditor subsequently relies in determining the nature, extent and timing of auditing procedures."

Disadvantages

1. Some practitioners disagree that the extent of a compliance test of internal controls "should be related directly (or as closely as possible) to the possible monetary effects of compliance deviations. Proponents of PUS (Physical Unit Sampling) for compliance testing believe a close monetary link is not essential".[11]

2. DUS has been tailored for use by external auditors. It involves accepting a population as materially correct if the projected error value falls below a certain range (materiality). Its portability to operational audits has not as yet been demonstrated.

3. Because DUS is a probability-proportional-to-size (PPS) sampling method, it is a powerful technique for detecting overstatement errors. In the audit of liability accounts, the prime concern generally is the understatement of such an account, or perhaps from an operational viewpoint, an understatement of revenue. Items that are small, but which should be larger, have little chance of being selected.

4. As for item 3 above, zero balances or negative physical units have no chance of being selected. In these situations, inferences can only be made using traditional sampling methods, i.e., variable estimation.

C. Conservatism

Advantage

1. In the evaluation process, DUS seeks to apply conservatism in the use of tainting percentages applied against precision-gap widening factors in descending order. Some PPS methods also assume that upper

stratum items (those physical units with values greater than the sampling interval) contribute to the increase in the calculated possible error. This approach again, contributes to the conservatism aspect.

Disadvantage

1. Arkin has stated the following about the conservatism implied by tainting doctrine:

"The approach results in a very conservative overstatement of the upper limits of the monetary errors."

He also says that the precision level calculated

"...is not, as in estimation sampling, an estimate of the probable maximum total error, but a value which is possibly the maximum given certain very conservative assumptions. It is virtually certain to be higher than the upper limit achieved by ordinary sampling techniques.

For monetary sampling, the upper limit is no longer a confidence limit. It has been suggested that this upper limit be referred to as an upper bound or boundary."[12]

Item 2, under the objectivity disadvantages illustrates numerically the conservative aspect described above. Although the DUS evaluation approach is conservative it cannot be expressed using classical statistical theory once the tainting philosophy is applied.

D. Objectivity

Advantage

1. DUS has gained acceptance in the auditing profession. Summarized in Whittaker's words:

"... one can say that the system produces seemingly satisfactory results which to date have not produced an unacceptable high level of negligence claims on auditing practitioners."[13]

Disadvantages

1. Although DUS requires the auditor to define explicitly the maximum error rate, i.e., planning materiality, Whittaker states the following:

"Auditors using this method, who are exposed to error bearing accounting populations must encounter a very discouraging number of samples that they have to reject, unless they are prepared to trim their standards to the results they discover. Instead, this is what happens. In a worked example in one handbook on the subject, materiality threshold is taken at Ł12,500; the sample evaluation produces a maximum possible error of Ł14,839, and the astonishing conclusion is drawn that although there were errors in the sample, the revised MP of Ł14,839 is satisfactory, and is accepted."[14]

2. The allocation of tainting percentages as applied to precision-gap widening factors, in the words of some "defies rational analysis".[14] Whittaker goes on to describe a situation where we could discover, in the extreme case, a \$5 error in an item which had a book value of \$10 or a 50% tainting percentage and the same projection would result if a \$10,000 error is found in an item of \$20,000. Notwithstanding this situation, let us assume a sampling interval of \$20,001 and a confidence level of 95%. One could conceive that an error, i.e., \$10,000 when applied as a first error could contribute as much as:

$$50\% \times \$20{,}001 \times 1.75 = \$17{,}500$$

or if it were the fourth error, as much as

$$50\% \times \$20{,}001 \times 1.40 = \$14{,}000$$

However, had the sampling interval been \$20,000, the contribution to possible error would have been a \$10,000 error. The item would have been part of the upper stratum, which is generally not projected. By setting the sampling interval higher by \$1, significantly different results are obtained. Both situations above demonstrate that conservative conclusions would be drawn.

E. Practicality

Advantages

1. From earlier discussions it was noted that variables sampling techniques typically require that auditors decide on or have knowledge of the following:

   - the appropriate confidence level;
   - the precision required;
   - the number of units in the population; and
   - estimated standard deviation of the population.

   Dollar Unit Sampling requires the auditor to make decisions on only the first two. Units in the population do not vary, since the population is homogeneous (the sampling unit is the dollar). At the same time, it assumes the book value is equal to the audit value in most instances.

2. Although DUS requires adding through the population as part of the selection procedures, footing accounts is a standard audit procedure outside the framework of sampling. Therefore, two procedures could be carried out as easily as one. Computer-assisted audit techniques also reduces the problem of large data sets.

3. When the Poisson approximation is used, DUS requires a simple formula to calculate the sample size. Effectively, the same formula can be used in the evaluation stage.

4. Because the dollar is the sampling unit, sampling using DUS can be applied throughout the trial balance. Each account need not be considered as a different population with different characteristics as is the case when using the variables approach. Each of the methods described earlier has strengths that depend on some prior knowledge of the population characteristics, particularly an estimate in the variation of values of physical items within the population.

5. The literature suggests that DUS generally results in smaller sample sizes. However, because of conservative evaluations, it is likely that auditors will reject populations more often that do not contain a material error.

6. The formula used for variables sampling is more complex than the Poisson approximation. For example, the standard error for stratified ratio estimation is given.[15]

$$SE = N \sqrt{\frac{\sum d_i^2 + (\bar{R} - 1)^2 \cdot \sum x_i^2 - 2(\bar{R} - 1) \cdot \sum x_i d_i}{n(n-1)}} \sqrt{1 - \frac{n}{N}}$$

where N = number of items in the population

d = Audit value - book value or

yi - xi

$\bar{R} = \frac{yi}{xi}$

n = number of sample items.

Although essentially not difficult to calculate, the formula could be somewhat intimidating to some auditors. Nevertheless, the literature has described successful application of the method, although with a caution that "certain specialized techniques of statistical sampling should not be used by the uninitiated and only by the initiate in appropriate circumstances".[16]

Disadvantages

1. Although variables sampling requires knowledge of more parameters to calculate sample size than does DUS, a number of methods are available for estimating standard deviations, for example, using the Grubbs & Weaver method[17] described in 1947, and estimating the range of values within the population.

2. Although for DUS the population need not be known, sample selection using a sampling interval involves adding through the population. This procedure becomes unwieldy when large quantities of data are involved and computer-assisted audit techniques are not feasible.

3. Although DUS is perceived to yield smaller sample sizes, Kaplan has suggested:

   "... if we wish not to reject populations which have trivial but non-zero error rates in them, we may need larger sample sizes in DUS than had previously been indicated."[18]

   "Auditors must therefore make some trade-off between the decrease in the range of uncertainty associated with a point estimate and the increased amount of auditing required to reduce this uncertainty."[19]

   This risk of rejection is viewed as alpha risk, i.e., the risk that one would conclude from the sample results, that the population contains a material error when, in fact, it does not. Most DUS sampling plans adjust planning materiality for such a concern, but they do not deal explicitly with the alpha risk.

   Appendix B involves a rigorous determination of necessary sample size such that both the beta risk and the alpha risk are controlled. It demonstrates that larger sample sizes are required using the same planning materiality; as shown in the Appendix, controlling both risks results in a sample approximately three times larger than in situations where it is not controlled. Further research is required in this area.

Conclusions

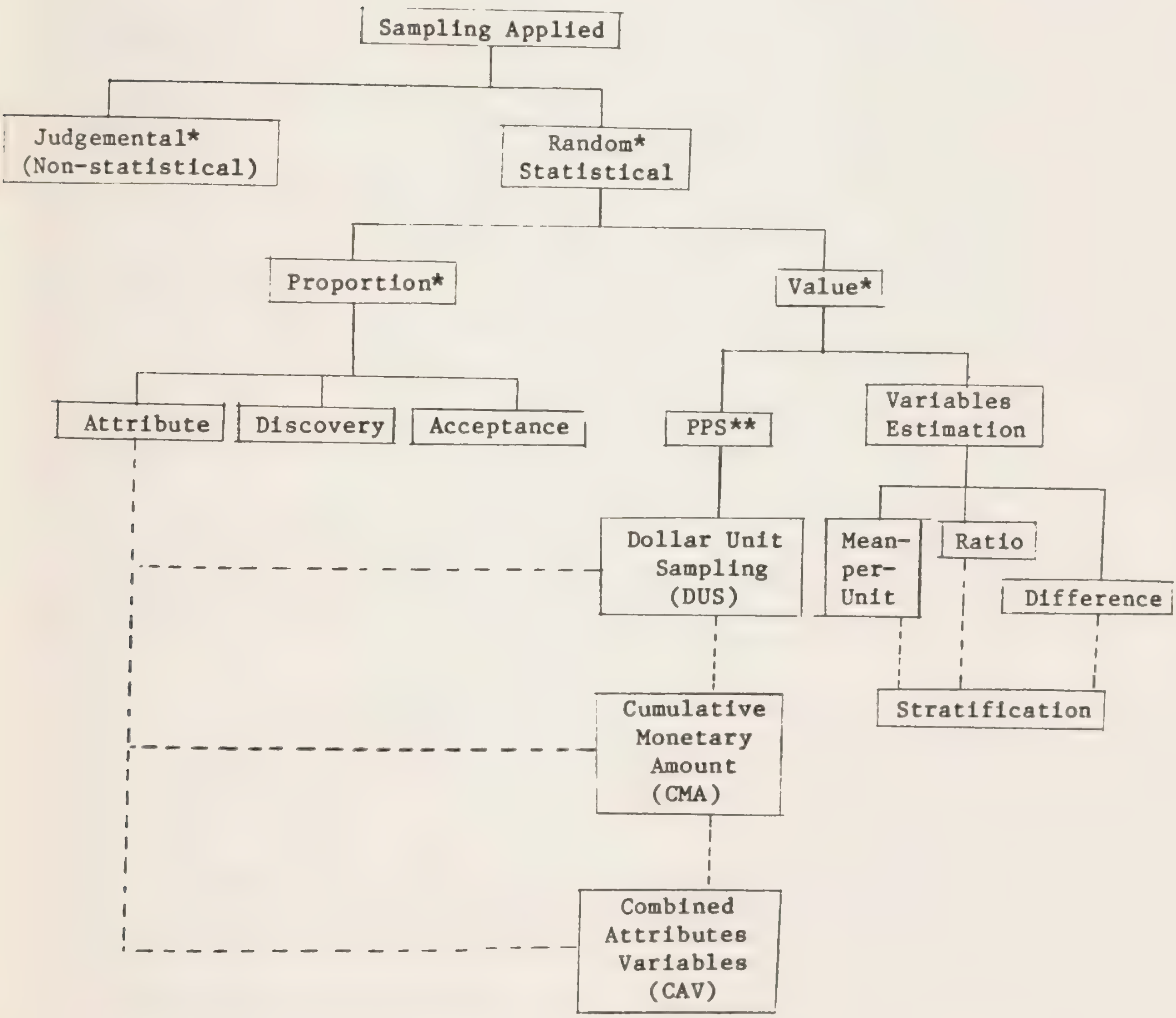
The overall advantage of DUS is that auditors have found it useful for auditing recorded populations and testing for overstatement, where expected

error rates are low and errors are expected to be between zero and an item's book value. The methodology is relatively easy to teach and can be applied manually or through a computer.

On the other hand, DUS is not particularly appropriate where there is no book value to audit (i.e., estimation mode), where high error rates are the main concern, and where unrecorded items are a concern.

Appendix A

Overview - Sampling Methodologies



* These distinctions are taken from T. McRae, see Reference 20.

** PPS - Refers to Probability-Proportional-to-Size Sampling - see AICPA Audit and Accounting Guide, "Audit Sampling" p. 67.

Appendix B

Illustration of DUS with both Alpha and Beta Risk

Assumptions

Alpha risk	=	.10	precision	=	.2PM
Beta risk	=	.15	precision	=	PM

where PM = planning materiality

Let N = sample size

k = number of 100% errors in the sample

Objective

To compare sample sizes that use Beta sample size factors where the number of 100% errors expected is nil and the situation satisfies both of the following conditions.

1. There is a 10% (alpha) risk that we would not reject the value of the population based on the sample evidence if the rate of error in the population is less than or equal to .2PM and,

2. there is a 15% (Beta) risk that we would accept the population based on our sample even though the error rate is greater than PM.

Let PM = $1 (it facilitates discussion)

$k = 0$

$.2n \leq .105*$ $\qquad$ $n \geq 1.90*$

$n \leq .525$

Conditions not satisfied

Appendix B

$k = 1$
$.2n \leq .532$
$n \leq 2.68$ $\quad\quad$ $n \geq 3.38$

Conditions not satisfied

$k = 2$
$.2n \leq 1.10$
$n \leq 5.5$ $\quad\quad$ $n \geq 4.73$

Conditions satisfied

Then if we calculate a sample size to satisfy such a situation, we must use a sample size factor in our formula, for Beta of 4.73 (or when two errors occur).

We now calculate a sample size, using Beta risk of 15%, but planning to tolerate 3 - 100% errors in our sample to also control the alpha risk.

(A) Sample Size (3 errors) = SS(2) $= 4.73 \times \dfrac{\text{Book Value}}{\text{PM}}$

(B) Sample Size (0 errors) = SS(0) $= 1.90 \times \dfrac{\text{Book Value}}{\text{PM}}$

$$\frac{SS(3)}{SS(0)} = (A) \div (B) = \frac{4.73}{1.90} = 2.5$$

Then when alpha is concurrently controlled, we find larger sample sizes. Essentially we stand less chance of rejecting populations because of sample evidence, at the cost of doing more audit work.

*Further discussion and corresponding tables can be found in an article by R. S. Kaplan, Journal of Accounting Research, Studies on Statistical Methodology in Auditing, pp. 126-133. Title is "Sample Size Computations for Dollar Unit Sampling".

REFERENCES

1. Kaplan, Robert S., Studies in Statistical Methodology in Auditing, Journal of Accountancy Research, Volume 1.3 Supplemental, 1975, p. 141.

2. Mendenhall , Ott, Scheaffer, Elementary Survey Sampling, Wadsworth Publishing Company, 1971, p. 5.

3. Loebbecke and Neter, Considerations in Choosing Statistical Sampling Procedures in Auditing, Studies on Statistical Methodology in Auditing, 1975, p. 38.

4. Cosserat, Judgement Sampling Rules OK!, Accountancy, April, 1983, p. 91, Some of the statements made include:

   "statistical sampling may be wasteful of much of an auditor's knowledge of the client and his financial records and accounts"

   "many of the problems encountered in the attest function cannot be neatly regimented"

5. Mendenhall, Ott, Scheaffer, Op. Cit., p. 7.

6. Anderson & Leslie, Discussion of Considerations in Choosing Statistical Sampling Procedures in Auditing, Studies on Statistical Methodology in Auditing, 1975, p. 61.

7. Leslie, Teitlebaum & Anderson, Dollar Unit Sampling, A Practical Guide for Auditors, Copp Clark Pitman, 1979, p. 391.

8. Felix, Leslie, Neter, University of Georgia Centre for Audit Research Monetary Unit Sampling Conference, March 24, 1981, Auditing, A Journal of Practice and Theory, Volume 1, No. 2, Winter, 1982, p. 94.

9. Newman, Financial Accounting Estimates Through Statistical Sampling by Computer, John Wiley and Sons, 1976, p. 54.

10. Loebbecke and Neter, Op. Cit., p. 43.

11. Felix, Leslie, Neter, Op. Cit., p. 95.

12. Arkin, Sampling Methods for the Auditor, An Advanced Treatment, McGraw-Hill Book Company, 1982, p. 128.

13. Whittaker, MUS - Effective Tool or Blunt Instrument?, Accountancy April, 1983, p. 90.

14. Whittaker, Op. Cit., p. 89.

15. Taken from Peat, Marwick, Mitchell & Co. PMI Statistical Sampling Manual.

16. Lentini, Using Ratio Estimation in Observing Inventories, The CPA Journal, June, 1981, p. 24.

17. McRae, T.W., Op. Cit., p. 42.

18. Kaplan, Robert S., Op. Cit., p. 142.

19. Kaplan, Robert S., Op. Cit., p. 137.

20. McRae, T.W., Statistical Sampling for Audit and Control, John Wiley and Sons.